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NEW AND OLD TASKS OF ERGONOMICS AT BASIC SCHOOL

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Abstract: *Child growth and development need suitable types and dosing of movement activities. Risk of insufficient movement activities (immobilization) belongs to significant risks of school attendance, besides infections and overloading. In the city of Brno 50 pedagogues have been inquired by means of anonymous questionnaires in 10 basic schools. Questions were focused on defects of the movement system with emphasising disorders of back (the incidence, diagnostics, prevention). In classrooms of one-fifth of the teachers there are children with orthopaedic disorders of back. Just parents should bring their children to regular and various movement activities, encourage them in proper life habits, motivate them by joy of movement; the school should use short exercise during lessons, motivation to movement in breaks, in interest groups and in out-of-school activities, reduced performance evaluations in physical training lessons and care of proper body posture.*

Keywords**:** *exercise, questionnaire, spinal column, motion, prevention, school, teacher, defect, back, pupil*

Introduction

Ergonomics is a new interdisciplinary scientific branch; its name comes from Greek words ergon = work, nomos = laws. In several countries other terms are used for this branch, e.g. "human engineering" or "biotechnology" (in the United States) or "Engineering psychology" (in Russia). Ergonomics is focused on effort to use findings of biological sciences effectively and intensively in design, planning, projects and construction of technical devices to serve people, in operation of the devices also with regards to appropriate environment. Biological factors of tools, machines, instruments, operating practice and environment are equivalent or dominant aspects besides technological, engineering and economical criteria *(Hrubá, 1995)*.

Ergonomics influences especially the following fields *(Hrubá, 1995):*

- Means for work (machines, tools);
- Working technology and placing;
- Organization of work and relaxation routine;
- Forms and ways of training and education;

- Protection of workers;
- Choice of workers.

School practice applications of ergonomics affect the following items *(Hrubá, 1995):*

- Equipment of general and specialized classrooms, cabinets, study rooms and other workplaces;
- Working processes, arrangement of workplaces;
- Organization of school time structure for teachers and pupils (lessons, breaks, work, relaxation, leisure time);
- Contents and forms of acting on pupils, apprentices students;
- Health damage prevention at school;
- Choice criteria of pedagogical workers and pupils.

In this paper the authors are focused on back disorders problems and their prevention.

Spinal column

The spinal column consists of 33–34 vertebrae: 7 cervical, 12 thoracic, 5 lumbar, 5 sacral vertebrae secondary fused to the sacrum and 4–5 vertebrae coccygeal that form the coccyx. They work as a functional system. Every vertebra consists of three parts of different function: the body, the arch and diapophyses. The vertebrae are mutually connected by joints, ligaments and muscles. By means of this structure the vertebrae can keep stable position of the body and are also movable to such extent that they enable various movements. Intervertebral discs between adjacent vertebrae act as absorbers to protect the spinal column against shocks and they influence the range of movement of individual spinal parts. So the mobility of the spinal column is given by the sum of movements between individual vertebrae; the range of movement is determined by the shape of junction surfaces, the shape and angle of vertebral spines and relative height of intervertebral discs *(Dobeš, Michková, 1997; Zelená, 2004).*

In the thoracic part the spinal column is connected with the ribcage and in the sacral part with the pelvis. Many ligaments and muscles are bound to the spinal column that carry out mutual movements of individual vertebrae resulting in movements of the whole spinal column and the body.

From the lateral view the spinal column shows multiple curvatures, which increases its stability. The curvatures must be proportional, the lordosis in the cervical area, the kyphosis in the thoracic area. The excessive lordosis is called hyperlordosis, the excessive kyphosis is hyperkyphosis. From the anteroposterioric view the physiologically minimal curvature is called scoliosis, the excessive curvature is considered to be pathological.

Basic movements of the spinal column are forward bends, backward bends, bends aside, rotations and springy movements *(Dobeš, Michková, 1997; Zelená, 2004).*

The spinal column ensures supporting and movement function – it acts as the support of the erect posture and as the movement axis of the body, it protects existing important nerve structures (the spinal cord, nerves,); it is the organ of high sensitivity

(it participates in keeping balance in the space) and also the organ representing mental processes. Proper function of the movement axis can influence not only the structures existing in the spinal canal but also function of the body movement system as a whole, i.e. limbs with joints, muscles and internal organs functions. Because of those multifunctional relationships the spinal column should always be perceived in connection with the function of the pelvis, the lower limbs and muscles *(Gúth et al., 2000; Zelená, 2004)*.

Importance of the spinal column to keeping balance has been clearly proved. The area of craniocervical junction, where deep nuchal reflexes originate, is considered to be very important. For keeping balance a correct proprioception is essential from this area, whereas the function of the internal ear labyrinth is not necessary. The spinal column, as the movement axis of the body and the organ of balance, works as a reflexively controlled function unit. If a position or function is changed at one end of the spinal column it is immediately manifested at the other end *(Lewit, 1990)*.

As regards the function of the spinal column, the most important part are the so called "key areas" or "key segments", the transition parts where functions of the spinal column are suddenly changing. It concerns the craniocervical, cervicothoracic, thoracolumbar and lumbosacral junctions *(Lewit, 1990)*.

The cervicocranial junction (head joints) enables extensive movements in all spatial directions and is able to bear the heavy head at the fragile cervical part of the spine. Functional discrepancies reduce mobility of this part, they can cause higher tonus of postural muscles and failure of balance.

In the cervicothoracic transition the very movable cervical spine passes into the least movable thoracic part of the spine. (The mobility is reduced by connection of ribs and the shoulder girdle with voluminous muscles). The spinal column is heavy loaded in the area of the thoracolumbar transition; here the movement mechanism of the thoracic spine is changed in the lumbar mechanism in the place of the last thoracic vertebra. The function discrepancy of this area results in spasms of many spinal, abdominal and pelvic muscles.

The lumbosacroiliac junction is the basis of the spinal column with decisive influence on the body statics. It transmits the motion from the lower limbs to the spinal column and acts as the shock absorber. The spine and pelvis represent a function unit. The pelvis connects the spine with the lower limbs; it transmits the motion from the lower limbs to the spinal column and acts as the shock absorber. In the pelvic area there are strong muscles and ligaments to ensure sufficient firmness. The pelvis consists of three associated bones: os illium, os ischii and os pubis. The symphysis line of the bones is approximately Y-shaped and goes through the acetabulum of the hip joint. The both parts of the pelvis are anteriorly connected with the discus interpubicus and posteriorly with the sacrum. The pelvic bone and the sacrum are connected in the sakroiliac junction that enables mobility of the pelvis. The function of the pelvis and its influence on the statics depend in substantial measure upon the pelvis type. Different pelvis types exist according to considerable variability of the last lumber vertebra, which is called "the transitional vertebra" *(Lewit, 1990; Zelená, 2004)*.

The key areas used to be the place of primary functional deficiencies of the spine that affect particularly children. They influence the whole spine, also due to secondary disorders - the spinal blocks *(Lewit, 1990)*.

Back muscles

The back muscles are sorted in three levels: the deep muscles of the back (intrinsic muscles), the intermediate muscles and the superfacial muscles. The deep muscles of the back are situated along the spinal column. The deeper muscle is, the shorter is the respective muscle fascicle. The shortest fascicles connect only two nearest segments.

The deepest layers of muscles influence mutual position of individual vertebrae. They are even activated by the thought of movement. They act in the sense of extension and several of them can decrease the pressure in the intervertebral discs. The intermediate layers connect more segments and control individual parts of the spine. Participation of the superfacial muscles in keeping the upright posture of the body is minimal; they play a role at instability.

The activation of the both sides of the back muscles complex enables extension of the spine at fixation of the pelvis. So the lumbar lordosis can be increased and the muscles are activated at respiration. At side bending the one side activation produces the rotation of vertebrae to the other side *(Véle, 1997)*.

Muscle syndromes

Functional defects of the motion system result in a gradual imbalance between the weakening physical system and the tonic system. The tonic system is getting dominant and becomes shorter. This imbalance is most evident in the area of the pelvis and the shoulder girdle.

The imbalance in the pelvic area is called *the lower cross syndrome;* it can change static and dynamic conditions in the pelvic area and the corresponding spinal parts. Consequently the pelvic anteversion is developed (the forward turnover) with the more significant lordosis in the lumbosacroiliac transition area and then the load distribution in the hip joints and spinal the segments is changed in the lumbar and sacral areas (mainly in the discs). Consequently the extension in the hip joint is insufficient and the anteversion of the spine can be intensified, which causes the continuing overload of the lumbosacroiliac spinal parts. The so generated anteversion is subsequently compensated by the lumbar hyperlordisis caused by the flexion in the hip joints. The hip is loaded unsteadily and responds to the situation by adaptation reconstructure of the bone. The intervertebral discs are also loaded enormously in this section and gradually degenerate. Also intervertebral joints are affected. Contractures can occur as reaction on painful excitations. This state can consequently influence walking *(Dobeš, Michková, 1997; Zelená, 2004)*.

In shoulder girdle the so called *upper cross syndrome* can occur. It is manifested by the forward head posture with overload of the cervical spinal column, by the increased cervical lordosis, the rounded, forward shoulders and change in position of shoulder-blades. Changes can appear in the shoulder girdle area, abduction of shoulder blades and overload of the muscular apparatus, which can cause change in position of the shoulder joint and degenerative changes. Disorder of the cervical spine can provoke change in the cervical sympaticus whose plexus is situated here and also the nerve structures connected with inner organs *(Dobeš, Michková, 1997; Zelená, 2004)*.

The third muscle syndrome is the *layer syndrome* with alternation of hypertrophic and hypotrophic muscle layers. At the dorsal side of the body the layers can exist of

hypertrophic and shortened muscles in the area of the hip, crura and glutea, hypertrophic erecting muscles in the area of the thoracal and lumbar spine, the layer of weakened inter-blade muscle and the layer of hypertrophic and shortened upper fibres of the rhomboid. In the front part of the body the weakened ventral muscle structures dominate with the shortened sternocleidomastoideus, the weakened deep flexor muscles, the hypertrophic shortened muscle iliopsoas and the straight semitendinosus *(Dobeš, Michková, 1997; Zelená, 2004)*.

Body posture evaluation

In the sagittal plane the human spinal column is visibly physiologically double curved. We can here find *(Lewit, 1990)*:

- Cervical (C) lordosis (the spinal column is arched with convexity forward);
- Thoracic (Th) kyphosis (arched with convexity backward);
- Lumbar (L) lordosis;
- Sacrococcygeal (S-Co) kyphosis.

Those curvatures make the spinal column more flexible and in a complex with the intervertebral discs they enable damping of vertical shocks, mainly by walking.

The spinal column of newborns is straight, its shape changes in dependence on the underlayment used. In the first months the child begins to lift up the head and at first the cervical lordosis begins to form. At sitting the thoracic and lumbar parts of spine are in one kyphotic bend – the dorso-lumbal kyphosis. The thoracic lordosis is formed as late as in the standing position. The final formation of the human spine is finished not before the age of twenty.

The upright posture is a complicated matter. The so called posture stereotype of the posture is ensured by participation of the inborn unconditioned reflexes and the acquired conditioned responses that ensure the posture stereotype. The posture is quite individual characteristic and exceptions considered as pathological can not be easily defined. Nevertheless the postural standard has been defined, which is used in attempts to evaluate and to define the posture variations. However, to declare a posture as pathologic is problematic (*Lewit, 1990)*.

Postural standard (Janda, 2001):

- Lateral view: the perpendicular going from the external auditory meatus going through the shoulder joint and the centre of hip joint, terminated in the os naviculare of the lower limb,
- Backward view: the perpendicular going from the back of the neck, touching the top of the thoracic kyphosis and then going through the intergluteal cleft.

Especially children are investigated in this way. If the child meets this standard its posture is declared to be the *proper* one. Each difference from the proper posture that is not caused by a structural change (inborn malformations of the spine or a disease, etc.) is considered to be *the defective posture (Janda, 2001)*.

Another simple and reliable investigation of the defective posture is the test of the posture by Matthias. The child is in the standing position with arms horizontally rai-

sed forward at 90º for 30 seconds. If the position is not substantially changed during this time, the posture is correct. If the head and the upper part of the thorax lean backward, the shoulders go forward and the belly is pushed up, the posture is incorrect *(Haladová, Nechvátalová, 1997)*.

Correctness of the posture should be checked in the body resting position, i.e. in the standing at attention position with the muscles relaxing but not relented *(Haladová, Nechvátalová, 1997)*.

The body posture of children can be evaluated by use of silhouettes images as proposed by Klein, Thomas and Mayer; these authors distinguish four types of the body posture: excellent, good, feeble and bad. Five basic criteria are evaluated: the head position; the thorax- and abdomen position; the spinal curvature; the position of shoulders blades, sides, thoraco-brachial triangles and the shoulder silhouettes (*Haladová, Nechvátalová, 1997)*.

Reasons for development of the defective body posture

The defective posture is included among diagnoses sorted within the wider term „*postural defects*". Those problems are very frequent; they affect substantial groups of population and concern function changes, later also structural changes connected with pains. Medicine has studied those problems since the end of 18th century. A lot of works exist that prove functional changes in about 80 percent of the population of children and youth *(Janda, 2001)*.

The muscular system is a decisive agent participating in development of the defective body posture. It is not only the muscular force which is decisive but mainly the balance between individual muscle groups. Deviations of the proper body posture are in most cases caused by muscular imbalances between muscles in the front and back sides of the body. In such a pair, the first of the muscles is postural with tendency to stiffen and the second is phasic with tendency to weaken. The both muscles compete in „tug-of-war" for the spine and the victory of the postural muscle against the physical one results in the defective body posture *(Tichý, 2000; Zelená, 2004)*.

There are many reasons for emergence of the defective body posture – the endogenous influences still have not been fully discovered, the exogenous influences are is close relation with life style changes. The most frequent cause is shortage of physical activities and exercises. This civilization factor concerns not only the adults but also the children involved in the sedentary lifestyle. This handicap exists even among children of the preschool age and if not detected in time, it becomes worse during the school attendance. Besides the shortage of moving activities among children, e.g. as the consequence of the passive sitting at TV or computers, the bad nutrition and consequently the obesity, participate in the muscular imbalance. Another factor with negative effect is the stress. The muscular imbalance can affect also the sporting children because of an unilateral load due to a certain sport - if it is not compensated with another exercises or procedures *(Janda, 2001; Zelená, 2004; Mužík, Krejčí, 1997)*.

The typical wrong body posture of children and adolescents is characterized with slack muscles and a loose ligament system. In standing position it is especially demonstrated by the pelvis turned over in the forward direction, the elevated abdominal wall, the higher lumbar lordosis and the thoracic kyphosis, in the upper body part by the pro-

truded shoulder blades with the prolonged shoulders and the forward head posture. The lower limbs are often bent.

For adults a certain type of defective body posture exists which is connected with structural changes of the spine or with a degenerative disease.

In most cases the defective body posture does not manifest an isolated local defect but it represents response to dysfunction of the whole motion system. The most sensitive structure is created by muscles that are considered to be a crossing area in which changes in both the peripherial parts of the movement system and the central system are reflected. Therefore according to the muscles reactions we can make conclusions on defects in the peripheral areas and also in the central part which controls movement actions *(Janda, 2001; Zelená, 2004)*.

Generally summarized: the defective body posture represents a set of divergences from a norm that can be purposely compensated by muscular activities. These functional defects are without evident structural changes, e.g. the slack body posture, flat back, child's round back protruded shoulder blades, scoliotic position of the spinal column. They originate from muscles imbalances as consequence of a lack of the movement activities, exercises, at unilateral load, eye sight defects, hearing defects, failures of mental development. It is manifested by shortening of hip flexors, knees, weakening of abdominal muscles, increasing of lumbar lordosis, flexion of head. When the long time problems are not detected and persist/are not solved, the described state is fixed as permanent, it can progress and the organic damages can appear *(Janda, 2001; Zelená, 2004)*.

Movement stereotypes

The dynamic movement stereotype is a temporarily constant system of conditioned and unconditioned reflexes which was developed on account of stereotypically repeating stimulations. Stereotypes are changed in time course, are influenced by internal factors and react to external environment changes *(Janda, 2001)*.

At healing of functional defects of the movement system and also the defective body posture the most important task is to improve incorrect movement schemes, when muscle coordination became negatively affected in consequence of defects of the central control. However, the movement stereotype is very individual and characteristic for each of individuals. It is created during the human ontogenesis as a chain of conditioned and unconditioned reflexes and it is not easy to define the threshold of a norm. In the ideal case the movement stereotypes should organize movements as economic as possible i.e. with the minimal energy consumption *(Lewit, 1990)*.

At evaluating of the movement stereotypes, the stage of activation and coordination is important for the muscles participated in the stereotype. The aim is to find if a pathological stereotype exists, if it is fixed and in what extent of fixation. The stereotype of the hip joint extension, the thorax flexion, the abduction of the hip joint, the shoulder joint and the neck flexion are evaluated most often. For each stereotype the ideal time sequence of muscular activation is defined *(Dobeš, Michková,1997)*.

The muscular imbalance, i.e. damping of physical muscles and hyperactivity of postural muscles, can substantially disturb coordination of movements and proper movement schemes. Reorganization of pathological movement schemes is very complica-

ted and time demanding, with need of active and qualified patient participation *(Lewit, 1990)*.

Sitting

In the course of social development the portion of sitting in human activities has been substantially multiplied. The movement system of the human body is overloaded not only by the increased physical effort but also by sedentary working conditions or by activities connected with the continuous and repeated load of specific movement segments. Also the everyday sitting during school lessons overloads the movement system of pupils. Not only back pains but also distant pains – headache, vertigo, formication or strong pains in extremities are the most often consequences of our modern time and they originate often from defects of the spine and the movement system.

The body posture and all movements can be realized either in the physiological way when the respective structures are protected by a suitable loading or the body posture is "flaccid" and the movements are unphysiological which can cause overloading. Each sitting position should be evaluated individually, with considering its purpose. Therefore it is accordingly important how relevant diseases, injuries and damages of the movement system can affect the joints and the muscular system and change mobility of the spine and the joints of extremities *(Rašev, 1992)*.

Rašev (1992) uses the term "back school" for acquiring skills for convenient behaviour towards one's own body and principles of a modest loading of the organism with using movement activities in a comprehensive methodical system. At the back school this optimal behaviour towards the own body is trained with the aim to change the long-life harmful habits responsible for all the troubles.

The most economical load of all spinal structures in the approximately normal state (muscles without shortening, suitable height of intervertebral discs, joints free movable in whole extent) – it is the position that must be poised. The balance is ensured by the poised muscles. It is the most convenient position that enables the axial load of supporting structures although is can be easily deflected. This position is not-stable but enables optimal distribution of loads acting on the intervertebral discs.

In the sitting position our body gravitates towards a loose sitting, with the rounded back, the pelvis flapped backwards; now the loading of intervertebral discs is uneconomical, the discs are wedge-shaped, the ligaments connecting vertebrae are disproportionately stretched. The short–lasting strong stress due to bending always brings negative effects but young undamaged structures can subjectively resist them for a long time. Such more often long-lasting and disadvantageous loading positions (the sitting with rounded backs and the forward head) impact substantially on creation of adaptive changes that enable the spine, its joints and muscles react to external effects and postpone threat of damage from overload.

If the body should sit upright, with the vertebral discs uniformly loaded in the whole surface, it must be supported by the system of muscles and joints. If the muscles are not shortened, have the normal structure and strength and are without damage effects, so the upright sitting can load economically the responsible muscle groups of the trunk and the extremities. More often, however, the floppy sitting posture is used, because the muscles are imbalanced, shortened and weakened. The sitting posture

with the rounded back can deform the intervertebral discs but is very well tolerated for a short term if the intervertebral discs had not been substantially damaged *(Rašev, 1992; Zelená, 2004)*.

Children often suffer from the kyphotic sitting position, which causes the overload of intervertebral discs, the sternum compression and the share-bone symphysis, the forward position of the head and the neck position and the hyperlordosis in the craniocervical passage. It can result in higher tension in majority of the postural muscles. The function of the whole spine can be compared with a system of mutually connected cogwheels: one of them is the cervical spine, the second is the thoracic spine and the third is the lumbar spine. Thus, even the lowest part of the spinal column can influence the highest part of the spine, i.e. any overloading of the lumbar spine after the long-term sitting can result in pathology of any other spine part.

For maximal release the Brügger sitting position is recommended; the patient is sitting at the very end of the stool, keeps his knees and legs apart, the legs propped, the abdominal and the gluteal muscles are floppy. Then the pelvis is tilted forward, the lumbosacral lordosis is enforced and the abdomen is arched forward. After assuming this position the upper lumbar, thoracic and cervical spinal parts are being evened up and reach the static balance. This sitting position can be a certain compensation of the common kyphotic sitting position which is the most frequent working position in the sedentary employment in the situation of muscles relaxed without any support *(Rašev, 1992; Zelená, 2004)*.

Proper standing position and posture

The body posture should be ensured by the muscular system with exerting a minimal energy for a certain long-term body position and without creating the bending stress that could cause overloading of characteristic structures. Simultaneously the optimal position is instable because the body structure can be easily shifted from this position.

In the upright position the body must permanently resist the gravitation. For the most economic function of the muscles it is necessary, at average curvatures of the spine, to adopt the standing position with the pelvis slightly leaned forward and the head kept upright. The shoulders should be kept in the natural position, not forced backwards.

The distance between the lumbar spine and the perpendicular going from the rear head should be 3-3.5 cm at maximum, the distance of the cervical spine 2 - 2.5 cm. The angle formed between the head and the body is 90º. The angle between the feet is 30º - 40º; at longer duration of the standing position it is recommended to transmit the weight from heels to tips and vice versa in order to avoid overloading the back muscles. The lumbar spine is in the middle position (Rašev, 1992*; Zelená, 2004*).

Methodology

A probe was carried out in the segment of pedagogical community in Brno town. The unstandardized and anonymous questionnaire *(Ševčíková, 2004)* with 14 items (5 with the closed offer of responses, 6 with the half-open and 3 with the free offer of responses), focused on etiology, diagnostics, incidence, school classes equipment,

therapy and prevention, addressed 50 teachers participated in the research from 10 randomly drafted Brno schools - 15 men and 35 women, their practice averaged 14 years, 43% of the respondents were teachers of the 1st grade of basic schools, 57 % of the 2nd grade of basic schools. Because of the small data collection, it was processed by univariate analysis.

Results

All respondents know some type of spinal defects of children. The most frequent responses of the teachers were: only scoliosis (68 %), scoliosis, kyphosis and lordosis concurrently (29 %). 2 % of responses were “the shifted vertebra”, “the pressed vertebra”, “the rounded and flat back”.

17 % of the respondents teach a pupil with a spinal defect. They were informed about the defect by the pupil or his parents (82 %), 18 % of respondents themselves found out this defect.

22 % of the respondents (only women) know methods for detecting spinal defects. They were informed on the methods: by physician, in medical consulting rooms, in studies at the Faculty of Education or by means of mass media. 68 % of the respondents are of the opinion that it is not necessary for teachers to know diagnostic methods used for discovery of spinal defects.

One half of the respondents (52 %) would like to know more about the issues of orthopaedic defects, 60 % of them would prefer the form of an information booklet, 40 % would choose an information seminary (here preferred mainly by women).

The most often responses of the question concerning causes of spinal were as follows:

- Lack of physical movement (52 %),
- Bad sitting position (57 %),
- Carrying heavy loads (52 %),
- Unsuitable school furniture (21 %),
- Rapid growth (21 %).

Most of the respondents were not properly informed about the appearance frequency of the defective body posture, muscular imbalances or spinal defect of children (80 % is usually quoted). The nearest answer to this literature data was “50 %”.

If the children affected by spinal defects are just in classes with the respondents as teachers, so in 47 % of such cases they are given preferential treatment by using two sets of textbooks (one set for the school, the second one for home) and by arrangement of exercise breaks.

More that three quarters of the pedagogues (84 %) try to guide the children to the proper body posture during their lessons, 52 % of them use verbal notice by calling attention to bad sitting with sequential advice to repair. About one third of the respondents (28 %) enable relaxation breaks for pupils with stretching exercises in all lessons to compensate the stiff sitting in school benches.

All schools participating in this research offer pupils activities of various interest groups. The most frequently quoted activities are:

- Floorball (36 %),
- Sporting games (36 %),
- Body ball exercise (15 %),
- Remedial exercise (31 %),
- Aerobic exercise and swimming (8 %).

69 % of the respondents consider the class equipment to be satisfactory, also for the pupils with the spinal defects, and they are positive about its preventive function.

The teachers offered the following most frequent changes concerning education:

- Equipment of the classes with vertically adjustable school benches and chairs to adapt them to pupils‘ height requirements (69 %),
- Integration of targeted compensation or relaxation exercises or at least stretching breaks in each of lessons (63 %),
- Installation of remedial exercises minimally for 1 hour/day (58 %),
- Possible purchase of two sets of exercise books not only for the pupils with spinal defects (47 %),
- Purchase of balls to supplement classical chairs (42 %),
- Development of physical leisure activities in in-school clubs and school interest groups (37 %),
- Opportunity for children to use sporting school areas during education hours and also in their leisure time (37 %).

This probe in the environment of basic schools demonstrated that the pedagogues had not usually exact opinion about mechanisms of the origin and diagnostics, possible healing methods and prevention of spinal defects. Because of high incidence of the above mentioned problems in groups of children and adults and also according to interest of teachers, the group of specialists from Department of Family Education and Health Education, Department of Special Education and other workplaces of Faculty of Education, Masaryk University prepared a special information booklet. Here interested persons can find basic facts about developmental spinal defects of children, methods used in detection of problems, the set of basic stretching or remedial exercises. For general overview we here offer several selected content parts of this booklet.

General possibilities for restoration of muscular balance

The first step for the restoration of muscle balance is to normalize conditions in peripheral structures of the movement system. An important part of remedy is release and stretching of shortened muscular structures and strengthening of their weakened parts. It is practically impossible to learn proper performance of the corresponding movements if it is complicated by existence of the shortened or weakened muscles.

Elimination of the muscle imbalance is the premise and precondition for re-education of physiological performance of more complicated movements, especially the everyday movements. Physical training focused on health is applied not only for recovery of muscle balance but especially for rehabilitation of correct movement processes.

The muscle balance must be fixed continuously by exercises because daily disturbing interferences often persist *(Kabelíková, Vávrová, 1997; Mužík, Krejčí, 1997)*.

Method of muscle balance restoration:

- Investigation of the stage of shortening of postural muscles, phasic muscles strength and movement stereotypes;
- Training of proper breathing stereotype, muscle stress release and proper performance of controlled movements (slow movements, tension movements, movements in coordination with breathing) used for stretching shortened muscles and for strengthening shortened muscles;
- Release and stretching of shortened muscles,
- Training of proper activation of appropriate muscles in movement schemes with the aim to create a correct movement routine;
- Finally, strengthening of weakened muscles *(Kopřivová, 2001).*

School chair usability for sitting

The nature of the human body is to change position often, not to remain at one place too long. Nevertheless, for working activities demanding on concentration our body must remain in a relatively stable position. This solution is not however suitable for our movement system because certain muscle groups are loaded statically more intensively and for longer time than the others.

In basic schools the pupils spend in the sitting position in the school bank number of hours per day and are demanded to be fully concentrated on learning. The structure of lessons does not enable them to move significantly during the lessons; therefore their movement system is statically considerably loaded. One of methods for solution of this problem is a system for dynamic sitting and proper choice of sitting furniture for school classes.

The systems for dynamic sitting enable to load dynamically both the postural and phasic muscle groups. Stress and release of muscles alternate, without influence on concentration and visual perception. It can be achieved by use of an unstable seat – by means of a vibration chair which enables not only the stress-release alternation but stimulates the effort to stabilize the sitting position without a substantial unilateral muscle activity needed for this stabilization.

The good chair should be equipped with such dynamic system but it is not often possible because of the school environment and economic reasons. Therefore it is advisable at least to practice dynamic sitting and to change various *(Rašev,1992).*

Each of chairs should fulfil the following conditions:

- Adjustable height of the seat;
- Spacious and comfortable seat space;
- Rounded front edge of the seat;
- Fixedly adjustable backrest, with ability to move in front-and-back direction;
- Backrest height should not exceed the shoulder blade area;
- Adjustable supporting cushion in the lumbar spine area.

There is a certain alternative of such chair with the dynamic sitting system, namely the gym-ball. It offers the balance surface that produces reactions of the movement system similar to using this chair. The gym-ball is financially available and easy to stock. Those balls can be placed in the gym room or the classroom, e.g. suspended

from the ceiling where they do not interfere in pupil's movement and usual operation of these rooms. The gym-balls can be used not only for exercise alone which becomes more interested for pupils but also for sitting at school bench in some lessons. In this way the balls can partially substitute unsuitable school chairs and influence positively the movement system of the pupils during lessons. The gym-ball can be profitably used also for exercise breaks in the classrooms.

Another aid exists to support the proper sitting, namely the sitting wedges. They enable a natural position with the pelvis flapped forwards and are soft enough to ensure the non-stiff position that can be continuously adapted to sedentary activities. Also this aid can be used for children sitting in the school banks *(Rašev, 1992).*

Training of proper sitting

Starting point is the sitting position at a horizontal surface or slightly declined forwards. The plane going through hip joints is several centimetres higher than the plane going through the knee joints. The heels are on the ground under the knee joints, the leg in the approximate angle of 45º and the feet follow the line of the thighs. The angles between the knee and the insteps are obtuse *(Rašev, 1992).*

Manoeuvres important for proper sitting:

- Pelvis flapped forwards;
- Thorax raised;
- Head in the body axis,
- Abdominal breathing,
- Shoulder relaxed, in external rotation, with pushed shoulder blades;
- Thighs in the angle of 45º, foots under knees, in slight external rotation.

Existence of some shortened muscles hinders accomplishment of the proper sitting position. Therefore in the training we can not be concentrated on achievement of a certain position until the stretching of shortened muscles is performed. It concerns especially pectorals, neck muscles, quadratus lumborum, lumbar erector spinae muscles, thigh muscles, hip joint flexors and calf muscles *(Rašev, 1992).*

Proper posture

The proper position of the standing body can be trained if the back is slightly leaned against the wall. In this way it can be easy checked if the spine curvatures agree with the theory. Our hand should fit in the sufficient distance (3 -3.5 cm) between the wall and the lumbar spine if the trunk is slightly pressed against the wall. Here the plumb line hung down can be advantageously used for correction of the posture. The plumb line hung down from the external auditory meatus should go through the shoulder, the centre of the hip joint, the knee and the forefoot. If the plumb is hung from the back of the neck in the frontal plate it should go through the spine, between haunches and end in the centre between the feet *(Rašev, 1992).*

Training of proper posture (modified by Dohnalová, 2002)

Upright head, the neck pulled back and up, the chin tighten slightly drawn to the chest and in the right angle with the neck axis;

- Thorax slightly arched forward;
- Spine smoothly physiologically curved;
- Shoulders released down and backwards;
- Shoulder blades enclose the back part of the thorax in all extent;
- Abdominal and gluteal muscles are contracted;
- Lower extremities are non-violently stretched in knees;
- Body mass is on external side of the extrinsic part of the front feet.

Discussion

This contribution is not presented as a collection of generalized inquiry data; it is only a probe which should earn more detailed verification with use of more numerous respondents from schools of a different character (situated in the city, smaller town, village).

From the data of this research it is evident that a discrepancy exists between the wish of pedagogues to know more about problems of spinal defects and the children's body movement system, and the knowledge and current occasion to get it.

There are various school furniture designs that consistently respect ergonomic demands. However, higher production costs and high quality materials are reflected in higher prices which can be a limiting factor in the education branch. Nevertheless, for a long time various organizations (health service institutions, hygienic stations, National Institute of Public Health etc.), paediatricians and professional public bodies have pointed out to issues of suitable and accessible school furniture; for the present, the simple and common solution has not been offered.

The body posture is a frequented concept that is used in various consequences with professional topics and practical life, with interference points in many branches. From the health care point of view the term "body posture" is interpreted as a representation of a maturity stage of neural-motoric functions and also as a symptom of various diseases and pathological processes, especially those concerning the movement system.

The posture is changing during the human life course. It is a dynamic process which is affected either positively or negatively by a lot of internal and external factors. The posture can be substantially influenced by individual behaviour and style of living.

For each profession the typical posture exists, which is caused by a long-term and unilateral loading of the movement system. Significant differences can be discovered e.g. for professions based on manual labour, in comparison with occupations with prevalence of sedentary work. In the both cases the loading is not, however, well balanced and it shoud be suitably compensated by other movement activities and relaxation. Similar situation occurs for children in the time of their obligatory school education, when the children spend the major part of the day in school benches and their leisure time usually at computers, TV or with another sedentary activity. Such style of living and insufficient movement motivations results in continuing overload of the movement system, defective posture, functional discrepancies and later structural malfunctions.

The posture is a very individual and to a certain extent subjective attribute. It is not easy to define a norm or a scale to evaluate if the posture is good or bad. Many

authors, professionals of the health care or physical education, deal with the problems of the posture and its evaluation in specialized (see e.g. *Janda, 2001; Rychlíková, 1994; Dvořák and Vařeka, 1999).* Although the definition itself of the defective posture and its evaluation are complicated, most of authors agree on primary prevention and remedy measures. The proposed means are mainly: to remove muscle imbalance, bad movement stereotypes, to motivate for convenient movement activities and to apply the back school principles on a long-term basis.

Most often the defective posture of children is detected in the basic school attendance age. In this period the children often change their lifestyle and reduce physical activities. It is just school environment that can significantly participate in influencing the health and movement ability of the school leavers. In this direction it depends on knowledge and approach of pedagogues used for motivation of pupils to proper movements and regular physical activities.

There is a lot of options and procedures to prevent emergence of body posture defects and to teach children the correct movement practice. In the present time many exercise and health aids are offered that are effective and attractive for pupils (e.g. gymballs). They can serve as a motivation element for the pupils and first of all they increase exercise effects.

The body posture problems have a bio-psycho-social character and they concern every human. For successful results of repair endeavour supported by health workers, pedagogues and other specialists, it is necessary to accept responsibility for own health and to start taking it as a value that must be actively pursued.

Conclusions

Child population is influenced by many risky moments in the style of living which includes also unsuitable working postures, movement stereotypes and low motivation to move. It is very important for pedagogues to know basic facts about issues of orthopaedic defects, their incidence, diagnostics, therapy and prevention. School represents a sample that can intervene in the life of pupils strongly and in a desirable way.

The pilot probe was performed in the environment of 10 basic schools, focused on the spinal column defects. From this investigation it has followed that there is a discrepancy between knowledge of the respondents and their willingness to learn more profound and topical information. The teachers use various methods to activate children, motivate them to movement activities and teach them to enjoy such movements. The school furniture can play an important both preventive and pathological role in the incidence of spinal defects. The conveniently selected furniture must respect ergonomic demands of users and enable not only convenient but also healthy sitting and undisturbed school working. The tasks of parents should be to guide children to regular and variable movements activities, to support proper lifestyle habits and joy of movement; the tasks of school are to use appropriately exercise breaks in lessons, to motivate to movement activities in the school break time, in interest groups, out-of-school activities, to reduce performance evaluations in physical training lessons and care for proper body posture.

The team of the authors from several workplaces of the Masaryk University, Faculty of Education, prepared a guideline with information about basic relaxation and

strengthening exercises, instructions for self-testing of physical ability and possible remedies of discovered imperfections/defects. The guideline is assumed to be published on web sites, prepared in the form of the e-learning course or CD.

Early prevention and remedial measures (in the family, in the kindergarten), that are applied in advance of organic damage of the movement system, restore harmony in the health quality system, improve the quality of life and enable better well-being in learning and at work. Also economic consequences are not negligible, e.g. lower consumption of medicaments, lesser medical benefits, lower number of sickness absence days, quicker return to the normal life, etc.

STARONOVÉ ÚKOLY ERGONOMIE NA ZÁKLADNÍ ŠKOLE

Abstrakt: Růst a vývoj dítěte s sebou přinášejí nutnost vhodného typu a dávkování pohybové aktivity. K hlavním rizikům školní docházky patří mimo infekcí a přetěžování též riziko nedostatku pohybu (imobilizace). Byla realizována sonda na 10 brněnských základních školách, kdy bylo pomocí anonymního dotazníku osloveno 50 pedagogů. Otázky byly zaměřeny na vady pohybového systému s důrazem na problémy se zády (výskyt, typy, diagnostika, prevence). Pětina učitelů má ve svých třídách děti s ortopedickými vadami zad. Úkolem rodičů by mělo být vedení dítěte k pravidelným a pestrým pohybovým aktivitám, podpora správných životních návyků a radosti z pohybu, k úloze školy patří vhodné využívání tělovýchovných chvilek ve výuce, motivace k pohybu o přestávkách, v kroužcích, na mimoškolních akcích, omezení výkonového hodnocení v tělesné výchově, podpora správného držení těla.

Klíčová slova: cvičení, dotazník, páteř, pohyb, prevence, škola, učitel, vada, záda, žák